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TITLE: Moving unit drive mechanism for actuator, operates moving unit linearly by expansion and contraction of flexible element consisting of approximately-coupled macromolecular particles such as polyanine and polypyrrole

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ABSTRACTED-PUB-NO: JP2000133854A

BASIC-ABSTRACT: NOVELTY - Power supply (2) and a voltage application unit (3) applies voltage to a flexible element (1) consisting of pi-coupled macromolecular particles such as polyanine and polypyrrole. Electrolyte (4) makes the flexible element conduct external current. Moving unit (6) is operated linearly by the expansion and contraction of the flexible element.

DETAILED DESCRIPTION - Flexible element expands when an electropositive

*same material
linear expansion*

potential is applied to the flexible element and contracts when an electronegative potential is applied to the flexible element.

USE - For actuator.

ADVANTAGE - Enables to obtain linear operation reliably and to reliably sustain the reciprocating motion of the moving unit with a simple mechanism. Forms the flexible element spirally and compactly and obtains strong operation power. Prevents damage of the actuator by absorbing external force.

DESCRIPTION OF DRAWING(S) - The figure shows the side view of actuator.

Flexible element 1

Power supply 2

Voltage application unit 3

Electrolyte 4

Moving unit 6

CHOSEN-DRAWING: Dwg.1/8

TITLE-TERMS:

MOVE UNIT DRIVE MECHANISM ACTUATE OPERATE MOVE UNIT LINEAR
EXPAND CONTRACT
FLEXIBLE ELEMENT CONSIST COUPLE MACROMOLECULAR PARTICLE

DERWENT-CLASS: A85 P62 V06

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Polymer Index [1.2]

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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the actuator which obtains linear operation by the flexible element expanded and contracted if voltage is impressed within the environment of the electrolyte section.

[0002]

[Description of the Prior Art] From the former, the actuator as shown in JP,6-6991,A is known. As shown in drawing 8, this actuator joins an electrode 16 to both sides of ion exchange membrane 15, and comes to prepare the polymer material layer 17 which covers this etc. In this case, either a cation exchange membrane or an anion exchange membrane can be used as ion exchange membrane 15, a polystyrene sulfonate film, fluororesin system ion exchange membrane with a sulfone machine or a carboxyl group, etc. are used as a cation exchange membrane, and the fluororesin system ion exchange membrane containing the ammonium and others are used as an anion exchange membrane. Moreover, the polymer material layer 17 is a thin coat, and becomes by water-insoluble nature polymer, such as polyethylene, polystyrene, and BORIAMIDO.

[0003] Therefore, in this actuator, it is impressing voltage to two electrodes 16 by the power supply section 2, and the potential difference is built over the front reverse side of ion exchange membrane 15, a difference is produced in the moisture content in this front reverse side, the low side of a water content contracts and this ion exchange membrane 15 carries out curve deformation to this low side (cathode side). This actuator which makes such deformation operation can be used as dynamogenesis mechanisms, such as an artificial muscle for micro robots.

[0004]

[Problem(s) to be Solved by the Invention] however, in the above-mentioned Prior art, although the polymer material layer 17 will also be expanded and contracted by impression of voltage, it was what carries out a chisel reaction and returns to the transient build-up current at the time of voltage impression immediately in this case to origin That is, even if it impressed voltage, when the current in ion exchange membrane 15 decreased, in order that the distribution of the once produced water content might be equalized gradually and might go, it was that from which a curve deformation state returns to the original state. So, in order to make the state where it elongated or contracted maintain, there was a problem that impressing repeat voltage had to be continued. Moreover, since it was that to which an actuator makes deformation operation only by contraction by the side of the low of the water content of ion exchange membrane 15, there was also a problem that the generating force at the time of this contraction required to obtain this deformation operation was weak.

[0005] this invention is offering the actuator which can make the gestalt which it is after being invented in order to solve the problem in the above-mentioned Prior art entirely, and the technical problem's being able to obtain linear operation certainly and this operating moreover maintain, without continuing carrying out repeat voltage impression

[0006]

[Means for Solving the Problem] The flexible element which the actuator of this invention according to claim 1 becomes by pi conjugate type polymeric materials, such as poly ANIN and polypyrrole. The power supply section for impressing voltage to this flexible element and the voltage impression section, and the electrolyte section for making the flexible element shell exterior flow through current, It ****, if an electropositive potential is impressed to the voltage impression section, a flexible element will develop, and it comes to prepare the move section which operates linearly by expansion and contraction of a flexible element on the main part of an actuator made as [contract / a flexible element] when the electronegative potential was impressed to the voltage impression section.

[0007] Therefore, expand and contract powerfully the flexible element which becomes by pi conjugate type polymeric materials by impressing positive and an electronegative potential to the voltage impression section in this case by oxidation-reduction reaction operation. Namely, if an electropositive potential is impressed to the voltage impression section, the amount of ion doping of a flexible element will increase, and this flexible element will be elongated. On the contrary, if an electronegative potential is impressed to the voltage impression section, the amount of ion doping of a flexible element will decrease, this flexible element will be contracted, and the move section certainly prepared in the main part of an actuator by this operates linearly. and this flexible element -- the state where it elongated or contracted -- the voltage impression section -- positive and negative -- it can be made to continue certainly, without repeating the gestalt of the main part of an actuator which operated, and continuing carrying out voltage impression, since it holds until reverse potential is impressed

[0008] The actuator of this invention according to claim 2 is characterized by having bias mechanisms, such as a spring which

generates the force to the direction where the move section operates at the time of extension of a flexible element, in the actuator of the claim 1 above-mentioned publication.

[0009] Therefore, although this extension force at the time of an electropositive potential being impressed to the voltage impression section especially in this case, and a flexible element being elongated becomes weaker than a shrinkage force when reverse, since the force to the direction where the move section operates according to a bias mechanism at the time of extension of a flexible element is generated, in case a flexible element is elongated, sufficient force of operation can be acquired. Moreover, since this shrinkage force at the time of a flexible element being contracted is comparatively strong, the generating force of the aforementioned bias mechanism is resisted, this flexible element contracts convenient, and the move section operates in the direction contrary to the above.

[0010] The actuator of this invention according to claim 3 is set to the actuator of the claim 1 above-mentioned publication. While carrying out the junction unification of the flexible element, forming a tabular layered product in the both sides of the electrolyte section and impressing an electropositive potential to the voltage impression section corresponding to one flexible element By impressing an electronegative potential to the voltage impression section corresponding to the flexible element of another side, it is characterized by for the flexible element of another side having contracted, while one flexible element developed, and making as [operate / linearly / the move section / so that this tabular layered product may be deformed by flexion / by nothing and this flexion deformity].

[0011] Therefore, by impressing positive and an electronegative potential to the voltage impression section especially in this case Since the move section operates linearly by the flexible element of another side contracting and deforming this tabular layered product by flexion by this at the same time one flexible element of a tabular layered product develops the voltage impression section -- positive and negative -- in case reverse potential is impressed and this tabular layered product is deformed by flexion to an opposite side, the same force of operation can occur, and it can have by the easy mechanism, and the move section can be made to move reciprocally certainly

[0012] In the actuator of the claim 3 above-mentioned publication, the actuator of this invention according to claim 4 arranges a pair of tabular layered product in an opposite position, carries out the joint unification of both the tabulars layered product at the end, and is characterized by preparing the move section which operates linearly in the plate surface and the ***** direction of this tabular layered product to a part for this bond part.

[0013] Therefore, opposite arrangement of the above-mentioned tabular layered product is carried out especially in this case, joint unification is carried out at both edge, and since the move section which operates linearly in the plate surface and the ***** direction of this tabular layered product to a part for this bond part is prepared, this move section can be made to move reciprocally in the state where it was certainly stabilized by flexion deformity of the tabular layered product of both sides.

[0014] The actuator of this invention according to claim 5 is characterized by preparing the move section which operates linearly into the middle portion of a tabular layered product towards carrying out an abbreviation rectangular cross with the plate surface of this tabular layered product in the actuator of the claim 3 above-mentioned publication.

[0015] Therefore, since the move section which operates linearly into the middle portion of the above-mentioned tabular layered product especially in this case towards carrying out an abbreviation rectangular cross with the plate surface of this tabular layered product is prepared, it can be made to move reciprocally in the direction which has this move section by this single tabular layered product, and carries out an abbreviation rectangular cross with this.

[0016] in the actuator of the claim 3 above-mentioned publication, as for the actuator of this invention according to claim 6, a periphery and the flexible element of another side serve as [the flexible element of one of these] inner circumference in a tabular layered product -- in a circle -- forming -- this -- it is characterized by making the part in the hoop direction of the tabular layered product which becomes in a circle with the move section which operates linearly in the direction of a path of this tabular layered product

[0017] Therefore, since the above-mentioned tabular layered product is formed in a circle especially in this case and the part in the hoop direction serves as the move section which operates linearly in the direction of a path It can become this move section and the easy structure which fixes a part of this tabular layered product which counters in the direction of a path by the opposite side, and can be made to move reciprocally in the state where it was certainly stabilized by flexion deformity to which a tabular layered product in a circle carries out huge reduction of this move section.

[0018] In the actuator of the claim 1 above-mentioned publication, the actuator of this invention according to claim 7 forms a flexible element in the shape of a spiral, and is characterized by preparing the move section which operates linearly along the direction of an axis of this spiral by expansion and contraction in alignment with the spiral curve of this flexible element in the edge of this flexible element.

[0019] therefore, a flexible element forms in the shape of a spiral especially in this case -- having -- compact -- being settled -- moreover -- this flexible element -- a spiral curve -- meeting -- a big variation rate -- an amount -- expanding and contracting -- this size -- a **** variation rate -- the small variation rate to which expansion and contraction of an amount met in the direction of an axis of this spiral -- since it is changed into linear operation of the move section used as an amount, the stronger force of operation can be acquired

[0020] In the actuator of the claim 7 above-mentioned publication, the actuator of this invention according to claim 8 is equipped with the bias mechanism which is the spiral-like spring which generates the force to the direction where the move section operates at the time of extension of a flexible element, and is characterized by unifying a flexible element in accordance with this bias mechanism.

[0021] Therefore, since unification formation of the flexible element of the shape of an above-mentioned spiral is carried out with this in accordance with the bias mechanism which is a spring especially in this case, in case the force to the direction where the move section operates is generated and a flexible element is elongated by this bias mechanism at the time of extension of a flexible element, sufficient force of operation can be acquired. Moreover, external force is absorbed by the bias mechanism, impossible operation of the move section is also lost, and it is hard coming to damage the main part of an actuator.

[0022]

[Embodiments of the Invention] Drawing 1 shows 1 operation gestalt corresponding to the claims 1-4 of this invention. the actuator of this operation gestalt The flexible element 1 which becomes by pi conjugate type polymeric materials, such as poly ANIN and polypyrrole The power supply section 2 and the voltage impression section 3 for impressing voltage to this flexible element 1, It has the electrolyte section 4 for making the flexible element 1 shell exterior flow through current. If an electropositive potential is impressed to the voltage impression section 3, the flexible element 1 will develop, and it comes to prepare the move section 6 which operates linearly by expansion and contraction of the flexible element 1 on the main part 5 of an actuator made as [contract / the flexible element 1] when the electronegative potential was impressed to the voltage impression section 3.

[0023] In the actuator of this operation gestalt, it has the bias mechanisms 7, such as a spring which generates the force to the direction where the move section 6 operates at the time of extension of the flexible element 1. Moreover, while carrying out the junction unification of the flexible elements 1a and 1b, forming the tabular layered product 8 in the both sides of the electrolyte section 4 and impressing an electropositive potential to voltage impression section 3a corresponding to one flexible element 1a By impressing an electronegative potential to voltage impression section 3b corresponding to flexible element 1b of another side Flexible element 1b of another side contracts at the same time one flexible element 1a develops, and it is making as [operate / linearly / the move section 6 / so that this tabular layered product 8 may be deformed by flexion / by nothing and this flexion deformity]. Moreover, a pair of tabular layered products 8 and 8 are arranged in an opposite position in this case, and the joint unification of both the tabulars layered products 8 and 8 is carried out at the end, and even if it forms the move section 6 which operates linearly to a part for this bond part in the plate surface and the ***** direction of these tabular layered products 8 and 8, it is.

[0024] The junction unification of the flexible elements 1a and 1b which the electrolyte section 3 becomes by the solid electrolyte of a complex-ion conductivity crystal and others, and become the both sides of this electrolyte section 3 by pi conjugate type polymeric materials, such as poly ANIN and polypyrrole, is carried out, and the tabular layered product 8 is formed. in this case, for example, SO4²⁻ which has a certain amount of molecular weight as an anion as the electrolyte section 3 H2SO4 to produce and Na2 SO4 Cl- HCL to produce and F- high pass filter6 to produce and HBF4 etc., although adopting is also possible Since it is necessary to use in the state of seal when the electrolyte section 3 serves as a fluid like an ion solution, it is desirable to use a solid electrolyte.

[0025] The joint unification of both the tabulars layered product 8 is carried out in the move section 6 by the soffit, at the edge same as the above, joint unification is carried out through the spacer 9 between voltage impression section 3b and 3b, and the bias mechanism 7 which comes by the spring between this spacer 9 and the move section 6 is stretched in the state of compression. In this case, a power supply section 2 and the voltage impression section 3 are formed in the aforementioned upper-limit side, this upper-limit side is fixed, and the move section 6 of the aforementioned soffit operates in the vertical direction.

[0026] Therefore, it sets to the actuator of this operation gestalt. Expand and contract powerfully the flexible element 1 which becomes by pi conjugate type polymeric materials by impressing positive and an electronegative potential to the voltage impression section 3 by oxidation-reduction reaction operation. Namely, if an electropositive potential is impressed to the voltage impression section 3, the amount of ion doping of the flexible element 1 will increase, and this flexible element 1 will be elongated. On the contrary, if an electronegative potential is impressed to the voltage impression section 3, the amount of ion doping of the flexible element 1 will decrease, this flexible element 1 will be contracted, and the move section 6 certainly prepared in the main part 5 of an actuator by this operates linearly. and this flexible element 1 -- the state where it elongated or contracted -- the voltage impression section 3 -- positive and negative -- it can be made to continue certainly, without repeating the gestalt of the main part 5 of an actuator which operated, and continuing carrying out voltage impression, since it holds until reverse potential is impressed The actuator of this operation gestalt that makes such deformation operation can be suitably used as dynamogenesis mechanisms, such as an artificial muscle for micro robots.

[0027] Moreover, it sets to the actuator of this operation gestalt. An electronegative potential is impressed to outside voltage impression section 3a, and flexible element 1a is contracted. Since both the tabulars layered product 8 will be in an expansion state and the force to the lower part in which the move section 6 operates according to the bias mechanism 7 is generated in that case as an electropositive potential is impressed to inside voltage impression section 3b, flexible element 1b is elongated and it is shown in drawing 1 (a), sufficient force of operation can be acquired. Moreover, an electropositive potential is impressed to outside voltage impression section 3a, and flexible element 1a is elongated. As an electronegative potential is impressed to inside voltage impression section 3b, flexible element 1b is contracted and it is shown in drawing 1 (b), both the tabulars layered product 8 will be in an incurvation state, and in that case, the generating force of the aforementioned bias mechanism 7 is resisted, and it operates to the upper part where it is convenient and the move section 6 is contrary to the above.

[0028] Moreover, it sets to the actuator of this operation gestalt. Flexible element 1b (1a) of another side contracts at the same time one flexible element 1a (1b) of the tabular layered product 8 develops by impressing positive and an electronegative potential to the voltage impression section 3. Since the move section 6 operates linearly by deforming this tabular layered product

8 by flexion by this the voltage impression section 3 -- positive and negative -- in case reverse potential is impressed and this tabular layered product 8 is deformed by flexion to an opposite side, the same force of operation can occur, and it can have by the easy mechanism, and the move section 6 can be made to move reciprocally certainly And opposite arrangement of the above-mentioned tabular layered product 8 is carried out in this case, joint unification is carried out at both edge, and since the move section 6 which operates linearly to a part for this bond part in the plate surface and the ***** direction of this tabular layered product 8 is formed, this move section 6 can be made to move reciprocally in the vertical direction in the state where it was certainly stabilized by flexion deformity of the tabular layered product 8 of both sides.

[0029] Drawing 2 shows another operation gestalt corresponding to the claims 1-4 of this invention, and sets it to the actuator of this operation gestalt. As are shown in drawing 2 (c), and the tabular layered product 8 is formed in the shape of a piece of a curve and it is shown in drawing 2 (a) and (b) That by which this tabular layered product 8 was connected up and down through the joint implement 10, and was connected with these upper and lower sides It is made a pair, and it is arranged in an opposite position, the joint unification of the soffit portion of both the lower tabulars layered product 8 is carried out through the move section 6, voltage impression section 3b shared between the upper-limit portions of both the upper tabulars layered product 8 is interposed, and the bias mechanism 7 is stretched between this voltage impression section 3b and the move section 6.

[0030] In this case, as an electropositive potential is conversely impressed to outside voltage impression section 3a as it can set in the operation gestalt shown in above-mentioned drawing 1, flexible element 1a is elongated, an electronegative potential is impressed to inside voltage impression section 3b, flexible element 1b is contracted and it is shown in drawing 2 (a), each tabular layered product 8 will be in an expansion state, and the move section 6 will operate below. Moreover, as an electronegative potential is impressed to outside voltage impression section 3a, flexible element 1a is contracted, an electropositive potential is impressed to inside voltage impression section 3b, flexible element 1b is elongated and it is shown in drawing 2 (b), each tabular layered product 8 will be in an incurvation state, and the move section 6 will operate upwards. In addition, except it, it is constituted like the operation gestalt shown in above-mentioned drawing 1, and the same operation effect is done so also in an account operation gestalt same as the above.

[0031] Drawing 3 showed still more nearly another operation gestalt corresponding to the claims 1, 3, and 5 of this invention, and has formed the move section 6 which operates linearly into the middle portion of the tabular layered product 8 towards carrying out an abbreviation rectangular cross with the plate surface of this tabular layered product 8 in the actuator of this operation gestalt. In this case, a part for the both ends is fixed as the fixed-end section 11, the tabular layered product 8 is arranged at an abbreviation level state, and the move section 6 is formed in the central inferior surface of tongue of this tabular layered product 8.

[0032] Therefore, it sets to the actuator of an operation gestalt. If an electropositive potential is impressed to voltage impression section 3a, upper flexible element 1a is elongated, an electronegative potential is impressed to voltage impression section 3b and lower flexible element 1b is contracted As shown in drawing 3 (b), the tabular layered product 8 is deformed by flexion so that a portion may curve upwards the middle, and the move section 6 operates upwards. If potential is impressed contrary to this, this tabular layered product 8 will be deformed by flexion so that a portion may curve below the middle, and the move section 6 will operate below. Moreover, a halt of impression of potential holds this tabular layered product 8 at a neutral straight-line state, as shown in drawing 3 (a). That is, it can be made to move reciprocally in the direction which has the move section 6 by the single tabular layered product 8 especially in this case, and carries out an abbreviation rectangular cross with this. In addition, except it, it is constituted like the operation gestalt shown in above-mentioned drawing 1, and the operation effect concerning claims 1 and 3 is similarly done so in an account operation gestalt same as the above.

[0033] drawing 4 -- claim 1- of this invention -- still more nearly another operation gestalt corresponding to 3 and 6 is shown, and flexible element 1b of a periphery and another side becomes [flexible element 1a of one of these] inner circumference about the tabular layered product 8 in the actuator of this operation gestalt -- in a circle -- forming -- this -- the part in the hoop direction of the tabular layered product 8 which becomes in a circle is made with the move section 6 which operates linearly in the direction of a path of this tabular layered product 8 In this case, voltage impression section 3b is arranged in the periphery side of the upper-limit portion of the tabular layered product 8 in a circle at the inner circumference side for voltage impression section 3a and an edge same as the above, and each is connected to the flexible elements 1a and 1b. Moreover, the move section 6 is formed in the inner circumference side of the soffit portion of this tabular layered product 8, and the bias mechanism 7 is stretched between this move section 6 and the aforementioned voltage impression section 3b.

[0034] Therefore, in the actuator of this operation gestalt, if an electropositive potential is impressed to voltage impression section 3a, flexible element 1a by the side of a periphery is elongated, an electronegative potential is impressed to voltage impression section 3b and flexible element 1b by the side of inner circumference is contracted, the tabular layered product 8 in a circle will carry out reduction deformation, and the move section 6 will operate upwards. If potential is impressed contrary to this, since the force to the lower part in which this tabular layered product 8 carries out huge deformation, the move section 6 operates below, and the move section 6 operates according to the bias mechanism 7 in that case will be generated, sufficient force of operation can be acquired.

[0035] Namely, the tabular layered product 8 is formed in a circle especially in this case, and the move section 6 which operates linearly in the direction of the diameter of the upper and lower sides into the soffit portion in the hoop direction is formed. It can become this move section 6 and the easy structure which fixes the upper-limit portion of this tabular layered product 8 which counters in the direction of a path by the opposite side, and this move section 6 can be made to move reciprocally in the vertical direction in the state where it was certainly stabilized by huge reduction deformation of the tabular layered product 8 in a circle.

The actuator of this operation gestalt that makes such deformation operation can be suitably used also as a dynamogenesis mechanism of pressure massage machines, such as a finger and an arm. In addition, except it, it is constituted like the operation gestalt shown in above-mentioned drawing 1, and the operation effect concerning claims 1-3 is similarly done so in an account operation gestalt same as the above.

[0036] Moreover, the actuator of this operation gestalt can also be suitably used as developmental mechanics of operation to which 2-dimensional STAGE13 is moved, as shown in drawing 5. In this case, around [of a circle configuration] STAGE13, opposite arrangement of two or more main parts 5 of an actuator is carried out, the move section 6 prepared in each main part 5 of an actuator is joined to the periphery of STAGE13, and the inner circumference portion of the in-a-circle frame 12 is joined to flexible element 1a by the side of the periphery of the portion which counters in the direction of a path by this move section 6 and the opposite side of each tabular layered product 8. Moreover, it is what the in-a-circle frame 12 is formed with a conductive material, is electrically connected with one voltage impression section 3a, and holds STAGE13 through each main part 5 of an actuator to the inside. Voltage impression section 3b of another side is respectively arranged in the move section 6 prepared in each main part 5 of an actuator, and a selection change of whether voltage is impressed to which voltage impression section 3b can be made with the selection switch 14. Therefore, STAGE13 held between the move sections 6 moving reciprocally can be operated towards desired on XY flat surface by operating the selection switch 14 in this case, and carrying out huge reduction deformation, as the tabular layered product 8 of the predetermined main part 5 of an actuator in a circle was mentioned above.

[0037] Drawing 6 showed still more nearly another operation gestalt corresponding to the claims 1 and 7 of this invention, formed the single flexible element 1 in the shape of a spiral in the actuator of this operation gestalt, and has formed the move section 6 which operates linearly along the direction of an axis of this spiral by expansion and contraction in alignment with the spiral curve of this flexible element 1 in the edge of this flexible element 1.

[0038] In this case, one voltage impression section 3a is formed in the shape of a pillar rod with copper, silver, platinum, etc. The electrolyte section 4 is ****(ed) by the whole periphery side of this voltage impression section 3a, and it is looped around in the shape of a spiral so that sliding of the band-like flexible element 1 may be attained in the periphery side of this electrolyte section 4. It connects with the upper limit of this flexible element 1 electrically, voltage impression section 3b of another side is fixed to it, and the move section 6 of the shape of a short cylinder fitted in the soffit of this flexible element 1 free [a vertical slide into the soffit portion of this electrolyte section 4] is combined.

[0039] Therefore, in the actuator of this operation gestalt, the flexible element 1 is formed in the shape of a spiral, and is settled compactly. Moreover, if an electropositive potential is impressed to voltage impression section 3b connected to the flexible element 1, this flexible element 1 will be elongated, and if an electronegative potential is impressed to said voltage impression section 3b, this flexible element 1 will be contracted. while the flexible element 1 ****s to the periphery side of the electrolyte section 4 by the slanting hoop direction along with a spiral curve in that case -- a big variation rate -- an amount -- expanding and contracting -- this size -- a **** variation rate -- the small variation rate to which expansion and contraction of an amount met in the direction of an axis of this spiral (pillar cylindrical longitudinal direction) -- it is changed into operation of the linear vertical direction of the move section 6 used as an amount, and the stronger force of operation can be acquired. In addition, except it, it is constituted like the operation gestalt shown in above-mentioned drawing 1, and the operation effect concerning a claim 1 is similarly done so in an account operation gestalt same as the above.

[0040] Drawing 7 shows still more nearly another operation gestalt corresponding to the claims 1, 7, and 8 of this invention, is equipped with the bias mechanism 7 which is the spring of the shape of same spiral which generates the force to the lower part in which the move section 6 operates at the time of extension of the flexible element 1 of the shape of an above-mentioned spiral in the actuator of this operation gestalt, and is unifying this flexible element 1 in accordance with this bias mechanism 7. In this case, as shown in drawing 7 (b), the bias mechanism 7 which becomes by spring-steel material is formed as one voltage impression section 3a, the flexible element 1 is ****(ed) by the whole superficies of this bias mechanism 7 through the electrolyte section 4, and **** covering of the voltage impression section 3b of another side is carried out at the whole superficies of this flexible element 1.

[0041] Therefore, in the actuator of this operation gestalt, since unification formation of the flexible element 1 of the shape of an above-mentioned spiral is carried out with this in accordance with the bias mechanism 7 which is a spring, in case the force to the lower part in which the move section 6 operates is generated and the flexible element 1 is elongated by this bias mechanism 7 at the time of extension of the flexible element 1, sufficient force of operation can be acquired. Moreover, external force is absorbed by the bias mechanism 7, impossible operation of the move section 6 is also lost, and it is hard coming to damage the main part 5 of an actuator. In addition, except it, it is constituted like the operation gestalt shown in above-mentioned drawing 6, and the same operation effect is done so also in an account operation gestalt same as the above.

[0042]

[Effect of the Invention] It expands and contracts powerfully and the move section certainly prepared in the main part of an actuator operates linearly, and moreover, the flexible element which becomes by pi conjugate type polymeric materials by impressing positive and an electronegative potential to the voltage impression section in [like / ****] the actuator of this invention according to claim 1 can be made to maintain certainly, without repeating the gestalt of the main part of an actuator which this operated, and continuing carrying out voltage impression.

[0043] Moreover, especially in the actuator of this invention according to claim 2, in case the force to the direction where the move section operates according to a bias mechanism at the time of extension of a flexible element is generated, sufficient force of operation can be acquired in case a flexible element is elongated, and a flexible element is contracted, a flexible element contracts

convenient and the move section operates in the reverse direction.

[0044] Moreover, it can be deformed by flexion by positive and carrying out negative conversion to the side with which a tabular layered product disagrees, it can have the potential impressed by the easy mechanism, and the move section can be made to move reciprocally certainly especially in the actuator of this invention according to claim 3.

[0045] Moreover, opposite arrangement is carried out and the above-mentioned tabular layered product can make the move section move reciprocally especially in the actuator of this invention according to claim 4 in the state where it was certainly stabilized by flexion deformity of the tabular layered product of these both sides.

[0046] Moreover, the move section prepared in the middle portion of the above-mentioned tabular layered product can be made to move reciprocally especially in the actuator of this invention according to claim 5 in the direction which has by this single tabular layered product, and carries out an abbreviation rectangular cross with this.

[0047] Moreover, the above-mentioned tabular layered product is formed in a circle, and a tabular layered product in a circle can make the move section in the hoop direction which becomes a part move reciprocally especially in the actuator of this invention according to claim 6 in the state where it was certainly stabilized by flexion deformity which carries out huge reduction.

[0048] Moreover, especially in the actuator of this invention according to claim 7, a flexible element is formed in the shape of a spiral, and is settled compactly, moreover expansion and contraction in the big amount of displacement which met in the shape of [of this flexible element] a spiral are changed into linear operation of the move section, and the stronger force of operation can be acquired.

[0049] Moreover, especially in the actuator of this invention according to claim 8, unification formation is carried out with the bias mechanism in which the flexible element of the shape of an above-mentioned spiral is a spring, in case this flexible element is elongated, sufficient force of operation can be acquired, and external force is absorbed, impossible operation of the move section is also lost, and it is hard coming to damage the main part of an actuator.

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3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The flexible element which becomes by pi conjugate type polymeric materials, such as poly ANIN and polypyrrole. The power supply section for impressing voltage to this flexible element and the voltage impression section, and the electrolyte section for making the flexible element shell exterior flow through current, The actuator which comes to prepare the move section which operates linearly by expansion and contraction of a flexible element on the main part of an actuator made as [contract / a flexible element] when it ****(ed), the flexible element developed when the electropositive potential was impressed to the voltage impression section, and the electronegative potential was impressed to the voltage impression section.

[Claim 2] The actuator according to claim 1 characterized by having bias mechanisms, such as a spring which generates the force to the direction where the move section operates, at the time of extension of a flexible element.

[Claim 3] While carrying out the junction unification of the flexible element, forming a tabular layered product in the both sides of the electrolyte section and impressing an electropositive potential to the voltage impression section corresponding to one flexible element By impressing an electronegative potential to the voltage impression section corresponding to the flexible element of another side The actuator according to claim 1 characterized by for the flexible element of another side having contracted while one flexible element developed, and making as [operate / linearly / the move section / so that this tabular layered product may be deformed by flexion / by nothing and this flexion deformity].

[Claim 4] The actuator according to claim 3 which arranges a pair of tabular layered product in an opposite position, carries out the joint unification of both the tabulars layered product at the end, and is characterized by preparing the move section which operates linearly in the plate surface and the ***** direction of this tabular layered product to a part for this bond part.

[Claim 5] The actuator according to claim 3 characterized by preparing the move section which operates linearly into the middle portion of a tabular layered product towards carrying out an abbreviation rectangular cross with the plate surface of this tabular layered product.

[Claim 6] a periphery and the flexible element of another side serve as [the flexible element of one of these] inner circumference in a tabular layered product -- in a circle -- forming -- this -- the actuator according to claim 3 characterized by making the part in the hoop direction of the tabular layered product which becomes in a circle with the move section which operates linearly in the direction of a path of this tabular layered product

[Claim 7] The actuator according to claim 1 characterized by preparing the move section which operates linearly along the direction of an axis of this spiral by the expansion and contraction which form a flexible element in the shape of a spiral, and meet the spiral curve of this flexible element in the edge of this flexible element.

[Claim 8] The actuator according to claim 7 characterized by having had the bias mechanism which is the spiral-like spring which generates the force to the direction where the move section operates at the time of extension of a flexible element, and uniting a flexible element with it in accordance with this bias mechanism.

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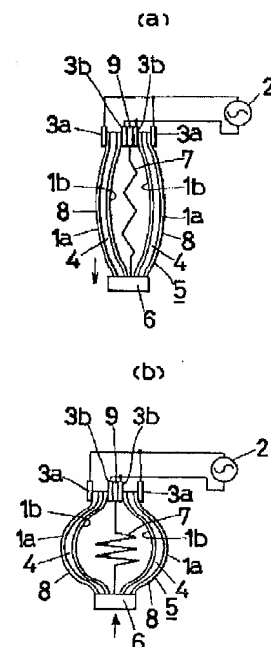
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(54) 【発明の名称】 アクチュエータ

(57) 【要約】

【課題】 直線的な動作を確実に得ることができ、動作された後の形態を持続させることもできるアクチュエータを提供する。

【解決手段】 ポリアニン、ポリピロール等の π 共役型高分子材料でなる伸縮素子1と、伸縮素子1に電圧を印加するための電源部2及び電圧印加部3と、電流を伸縮素子1から外部に導通させるための電解質部4と、を有し、電圧印加部3に正の電位を印加すると伸縮素子1が伸張し、電圧印加部3に負の電位を印加すると伸縮素子1が収縮するようになったアクチュエータ本体5に、伸縮素子1の伸縮によって直線的に動作される移動部6を設けてなる。



【特許請求の範囲】

【請求項1】 ポリアニン、ポリピロール等の π 共役型高分子材料でなる伸縮素子と、該伸縮素子に電圧を印加するための電源部及び電圧印加部と、電流を伸縮素子から外部に導通させるための電解質部と、を有し、電圧印加部に正の電位を印加すると伸縮素子が伸張し、電圧印加部に負の電位を印加すると伸縮素子が収縮するようにしたアクチュエータ本体に、伸縮素子の伸縮によって直線的に動作される移動部を設けてなるアクチュエータ。

【請求項2】 伸縮素子の伸張時に移動部が動作される方向への力を発生するばね等のバイアス機構を備えたことを特徴とする請求項1記載のアクチュエータ。

【請求項3】 電解質部の両側に伸縮素子を接合一体化して板状積層体を形成し、一方の伸縮素子に対応する電圧印加部に正の電位を印加すると共に、他方の伸縮素子に対応する電圧印加部に負の電位を印加することにより、一方の伸縮素子が伸張すると同時に他方の伸縮素子が収縮して、同板状積層体が屈曲変形されるようになり、該屈曲変形によって移動部が直線的に動作されるようになしたことを特徴とする請求項1記載のアクチュエータ。

【請求項4】 対の板状積層体を対向位置に配設して両板状積層体を端部で結合一体化し、該結合部分に同板状積層体の板面と略沿う方向で直線的に動作される移動部を設けたことを特徴とする請求項3記載のアクチュエータ。

【請求項5】 板状積層体の中程部分に、該板状積層体の板面と略直交する方向で直線的に動作される移動部を設けたことを特徴とする請求項3記載のアクチュエータ。

【請求項6】 板状積層体をその一方の伸縮素子が外周、他方の伸縮素子が内周となる円環状に形成し、該円環状となる板状積層体の周方向における一部分を、同板状積層体の径方向で直線的に動作される移動部となしたことを特徴とする請求項3記載のアクチュエータ。

【請求項7】 伸縮素子をスパイラル状に形成し、該伸縮素子のスパイラル曲線に沿う伸縮により同スパイラルの軸線方向に沿って直線的に動作される移動部を、同伸縮素子の端部に設けたことを特徴とする請求項1記載のアクチュエータ。

【請求項8】 伸縮素子の伸張時に移動部が動作される方向への力を発生するスパイラル状のスプリングであるバイアス機構を備え、該バイアス機構に沿って伸縮素子を一体化したことを特徴とする請求項7記載のアクチュエータ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、電解質部の環境内で電圧を印加すると伸縮する伸縮素子によって直線的な

動作を得るアクチュエータに関するものである。

【0002】

【従来の技術】 従来から、特開平6-6991号公報に示されるようなアクチュエータは知られている。該アクチュエータは、図8に示す如く、イオン交換膜15の両面に電極16を接合し、これ等を被覆するポリマー材料層17を設けてなるものである。この場合、イオン交換膜15として陽イオン交換膜或いは陰イオン交換膜のいずれをも使用することができ、陽イオン交換膜としては、ポリスチレンスルホン酸膜、スルホン基やカルボキシル基をもつフッ素樹脂系イオン交換膜等が用いられ、陰イオン交換膜としては、アンモニウム基を含んだフッ素樹脂系イオン交換膜その他が用いられる。又、ポリマー材料層17は薄い被膜であり、ポリエチレン、ポリスチレン、ポリアミド等の水不溶性ポリマーでなる。

【0003】 したがって、該アクチュエータにおいては、電源部2によって電圧を両電極16に印加することで、イオン交換膜15の表裏に電位差がかかって該表裏での水分量に差を生じ、同イオン交換膜15は含水率の低い側が収縮して該低い側（陰極側）へ湾曲変形する。このような変形動作をなす同アクチュエータは、例えば、超小型ロボット用の人工筋肉等の動力発生機構として利用することができる。

【0004】

【発明が解決しようとする課題】 しかしながら、上記従来の技術においては、ポリマー材料層17も電圧の印加によって伸縮することになるが、この場合、電圧印加時の立ち上がり電流にのみ反応しすぐに元へと戻ってしまうものであった。すなわち、電圧を印加しても、イオン交換膜15内の電流が減少すれば、一旦生じた含水率の分布は徐々に平均化されて行くため、湾曲変形状態が元の状態へと戻ってしまうものであった。それ故に、伸張或いは収縮された状態を持続させるためには、繰り返し電圧を印加し続けなければならないという問題があった。又、イオン交換膜15の含水率の低い側の収縮によってのみアクチュエータは変形動作をなすものであるため、該変形動作を得るに必要な同収縮時の発生力が弱いという問題もあった。

【0005】 本発明は、上記従来の技術における問題を悉く解決するために発明されたもので、その課題は、直線的な動作を確実に得ることができ、しかも、該動作された後の形態を、繰り返し電圧印加し続けることなく持続させることができるアクチュエータを提供することである。

【0006】

【課題を解決するための手段】 本発明の請求項1記載のアクチュエータは、ポリアニン、ポリピロール等の π 共役型高分子材料でなる伸縮素子と、該伸縮素子に電圧を印加するための電源部及び電圧印加部と、電流を伸縮素子から外部に導通させるための電解質部と、を有し、電

圧印加部に正の電位を印加すると伸縮素子が伸張し、電圧印加部に負の電位を印加すると伸縮素子が収縮するようになったアクチュエータ本体に、伸縮素子の伸縮によって直線的に動作される移動部を設けてなる。

【0007】したがって、この場合、電圧印加部に正、負の電位が印加されることによって π 共役型高分子材料でなる伸縮素子は酸化還元反応作用により強力に伸縮し、すなわち、電圧印加部に正の電位を印加すると伸縮素子のイオンドーピング量が增大して該伸縮素子は伸張し、逆に、電圧印加部に負の電位を印加すると伸縮素子のイオンドーピング量が減少して該伸縮素子は収縮し、これによって確実にアクチュエータ本体に設けられる移動部が直線的に動作される。しかも、同伸縮素子はその伸張或いは収縮された状態を電圧印加部に正、負逆の電位が印加されるまで保持するので、動作されたアクチュエータ本体の形態を繰り返し電圧印加し続けることなく確実に持続させることができる。

【0008】本発明の請求項2記載のアクチュエータは、上記請求項1記載のアクチュエータにおいて、伸縮素子の伸張時に移動部が動作される方向への力を発生するばね等のバイアス機構を備えたことを特徴とする。

【0009】したがって、この場合は特に、電圧印加部に正の電位が印加されて伸縮素子が伸張される際の該伸張力は逆の際の収縮力よりも弱くなるものであるが、バイアス機構によって伸縮素子の伸張時に移動部が動作される方向への力が発生されるので、伸縮素子が伸張される際にも充分な動作力を得ることができる。又、伸縮素子が収縮される際の該収縮力は比較的強いので、前記バイアス機構の発生力に抗し支障なく同伸縮素子が収縮して移動部は前記と逆の方向へ動作される。

【0010】本発明の請求項3記載のアクチュエータは、上記請求項1記載のアクチュエータにおいて、電解質部の両側に伸縮素子を接合一体化して板状積層体を形成し、一方の伸縮素子に対応する電圧印加部に正の電位を印加すると共に、他方の伸縮素子に対応する電圧印加部に負の電位を印加することにより、一方の伸縮素子が伸張すると同時に他方の伸縮素子が収縮して、同板状積層体が屈曲変形されるようになり、該屈曲変形によって移動部が直線的に動作されるようになしたことを特徴とする。

【0011】したがって、この場合は特に、電圧印加部に正、負の電位が印加されることによって、板状積層体の一方の伸縮素子が伸張すると同時に他方の伸縮素子が収縮し、これにより該板状積層体が屈曲変形されることによって移動部は直線的に動作されるので、電圧印加部に正、負逆の電位を印加して同板状積層体を反対側へ屈曲変形させる際にも同様の動作力が発生し、簡単な機構でもって移動部を確実に往復運動させることができる。

【0012】本発明の請求項4記載のアクチュエータは、上記請求項3記載のアクチュエータにおいて、対の

板状積層体を対向位置に配設して両板状積層体を端部で結合一体化し、該結合部分に同板状積層体の板面と略沿う方向で直線的に動作される移動部を設けたことを特徴とする。

【0013】したがって、この場合は特に、上記板状積層体が対向配置されて両者の端部で結合一体化され、該結合部分に同板状積層体の板面と略沿う方向で直線的に動作される移動部が設けられているので、該移動部を両側の板状積層体の屈曲変形によって確実に安定した状態で往復運動させることができる。

【0014】本発明の請求項5記載のアクチュエータは、上記請求項3記載のアクチュエータにおいて、板状積層体の中程部分に、該板状積層体の板面と略直交する方向で直線的に動作される移動部を設けたことを特徴とする。

【0015】したがって、この場合は特に、上記板状積層体の中程部分に、該板状積層体の板面と略直交する方向で直線的に動作される移動部が設けられているので、該移動部を単一の同板状積層体でもってこれと略直交する方向に往復運動させることができる。

【0016】本発明の請求項6記載のアクチュエータは、上記請求項3記載のアクチュエータにおいて、板状積層体をその一方の伸縮素子が外周、他方の伸縮素子が内周となる円環状に形成し、該円環状となる板状積層体の周方向における一部分を、同板状積層体の径方向で直線的に動作される移動部となしたことを特徴とする。

【0017】したがって、この場合は特に、上記板状積層体が円環状に形成され、その周方向における一部分が径方向で直線的に動作される移動部となるので、該移動部と反対側で径方向に対向する同板状積層体の一部分を固定するだけの簡単な構造となり、同移動部を円環状の板状積層体が膨大縮小する屈曲変形によって確実に安定した状態で往復運動させることができる。

【0018】本発明の請求項7記載のアクチュエータは、上記請求項1記載のアクチュエータにおいて、伸縮素子をスパイラル状に形成し、該伸縮素子のスパイラル曲線に沿う伸縮により同スパイラルの軸線方向に沿って直線的に動作される移動部を、同伸縮素子の端部に設けたことを特徴とする。

【0019】したがって、この場合は特に、伸縮素子がスパイラル状に形成されてコンパクトに納まり、しかも、該伸縮素子はスパイラル曲線に沿って大きな変位量で伸縮して、該大きな変位量の伸縮が同スパイラルの軸線方向に沿った小さな変位量となる移動部の直線的な動作に変換されるので、より強い動作力を得ることができる。

【0020】本発明の請求項8記載のアクチュエータは、上記請求項7記載のアクチュエータにおいて、伸縮素子の伸張時に移動部が動作される方向への力を発生するスパイラル状のスプリングであるバイアス機構を備

え、該バイアス機構に沿って伸縮素子を一体化したことを特徴とする。

【0021】したがって、この場合は特に、上記スパイラル状の伸縮素子がスプリングであるバイアス機構に沿ってこれと一体化形成されるので、該バイアス機構によって伸縮素子の伸張時に移動部が動作される方向への力が発生され、伸縮素子が伸張される際にも充分な動作力を得ることができる。又、バイアス機構によって外力が吸収され移動部の無理な動作もなくなって、アクチュエータ本体は破損し難くなる。

【0022】

【発明の実施の形態】図1は、本発明の請求項1〜4に対応する一実施形態を示し、該実施形態のアクチュエータは、ポリアニン、ポリピロール等の π 共役型高分子材料でなる伸縮素子1と、該伸縮素子1に電圧を印加するための電源部2及び電圧印加部3と、電流を伸縮素子1から外部に導通させるための電解質部4と、を有し、電圧印加部3に正の電位を印加すると伸縮素子1が伸張し、電圧印加部3に負の電位を印加すると伸縮素子1が収縮するようになったアクチュエータ本体5に、伸縮素子1の伸縮によって直線的に動作される移動部6を設けてなる。

【0023】該実施形態のアクチュエータにおいては、伸縮素子1の伸張時に移動部6が動作される方向への力を発生するばね等のバイアス機構7を備えている。又、電解質部4の両側に伸縮素子1a、1bを接合一体化して板状積層体8を形成し、一方の伸縮素子1aに対応する電圧印加部3aに正の電位を印加すると共に、他方の伸縮素子1bに対応する電圧印加部3bに負の電位を印加することにより、一方の伸縮素子1aが伸張すると同時に他方の伸縮素子1bが収縮して、同板状積層体8が屈曲変形されるようになり、該屈曲変形によって移動部6が直線的に動作されるようになっている。又、この場合、対の板状積層体8、8を対向位置に配設して両板状積層体8、8を端部で結合一体化し、該結合部分に同板状積層体8、8の板面と略沿う方向で直線的に動作される移動部6を設けてもいる。

【0024】電解質部3は銀イオン導電性結晶その他の固体電解質でなり、該電解質部3の両側にポリアニン、ポリピロール等の π 共役型高分子材料でなる伸縮素子1a、1bが接合一体化されて板状積層体8は形成されている。この場合、電解質部3として、陰イオンとしてある程度の分子量を有する、例えば、 SO_4^{2-} を生じる H_2SO_4 、 Na_2SO_4 や、 Cl^- を生じる HCl や、 F^- を生じる HPF_6 、 HBF_4 等を採用することも可能ではあるが、電解質部3がイオン溶液のように流体となる場合には密封状態で用いる必要があるので、固体電解質を使用することが好ましい。

【0025】両板状積層体8はその下端で移動部6にて結合一体化され、同上端では電圧印加部3b、3b間のスベ

ーサ9を介して結合一体化されており、該スパーサ9と移動部6との間にスプリングでなるバイアス機構7が圧縮状態で張設されている。この場合、前記上端側に電源部2及び電圧印加部3が設けられ、該上端側が固定されて、前記下端の移動部6が上下方向に動作される。

【0026】したがって、該実施形態のアクチュエータにおいては、電圧印加部3に正、負の電位が印加されることによって π 共役型高分子材料でなる伸縮素子1は酸化還元反応作用により強力に伸縮し、すなわち、電圧印加部3に正の電位を印加すると伸縮素子1のイオンドーピング量が增大して該伸縮素子1は伸張し、逆に、電圧印加部3に負の電位を印加すると伸縮素子1のイオンドーピング量が減少して該伸縮素子1は収縮し、これによって確実にアクチュエータ本体5に設けられる移動部6が直線的に動作される。しかも、同伸縮素子1はその伸張或いは収縮された状態を電圧印加部3に正、負逆の電位が印加されるまで保持するので、動作されたアクチュエータ本体5の形態を繰り返し電圧印加し続けることなく確実に持続させることができる。このような変形動作をなす該実施形態のアクチュエータは、例えば、超小型ロボット用の人工筋肉等の動力発生機構として好適に利用することができる。

【0027】又、該実施形態のアクチュエータにおいては、外側の電圧印加部3aに負の電位が印加されて伸縮素子1aが収縮され、内側の電圧印加部3bに正の電位が印加されて伸縮素子1bが伸張されて、図1(a)に示す如く、両板状積層体8は伸展状態となり、その際、バイアス機構7によって移動部6が動作される下方への力が発生されるので、充分な動作力を得ることができる。又、外側の電圧印加部3aに正の電位が印加されて伸縮素子1aが伸張され、内側の電圧印加部3bに負の電位が印加されて伸縮素子1bが収縮されて、図1(b)に示す如く、両板状積層体8は屈曲状態となり、その際、前記バイアス機構7の発生力に抗し支障なく移動部6は前記と逆の上方へ動作される。

【0028】又、該実施形態のアクチュエータにおいては、電圧印加部3に正、負の電位が印加されることによって、板状積層体8の一方の伸縮素子1a(1b)が伸張すると同時に他方の伸縮素子1b(1a)が収縮し、これにより該板状積層体8が屈曲変形されることによって移動部6は直線的に動作されるので、電圧印加部3に正、負逆の電位を印加して同板状積層体8を反対側へ屈曲変形させる際にも同様の動作力が発生し、簡単な機構でもって移動部6を確実に往復運動させることができる。しかも、この場合、上記板状積層体8が対向配置されて両者の端部で結合一体化され、該結合部分に同板状積層体8の板面と略沿う方向で直線的に動作される移動部6が設けられているので、該移動部6を両側の板状積層体8の屈曲変形によって確実に安定した状態で上下方向に往復運動させることができる。

【0029】図2は、本発明の請求項1～4に対応する別の実施形態を示し、該実施形態のアクチュエータにおいては、図2(c)に示す如く、板状積層体8が湾曲片状に形成され、図2(a)(b)に示す如く、同板状積層体8が結合具10を介して上下に連結され、該上下に連結されたものが、対にして対向位置に配設され、下側の両板状積層体8の下端部分が移動部6を介して結合一体化され、上側の両板状積層体8の上端部分間に共用される電圧印加部3bが介設されて、該電圧印加部3bと移動部6との間にバイアス機構7が張設されている。

【0030】この場合、上記図1に示した実施形態におけるとは逆に、外側の電圧印加部3aに正の電位が印加されて伸縮素子1aが伸張され、内側の電圧印加部3bに負の電位が印加されて伸縮素子1bが収縮されて、図2(a)に示す如く、各板状積層体8は伸展状態となり、移動部6は下方へ動作される。又、外側の電圧印加部3aに負の電位が印加されて伸縮素子1aが収縮され、内側の電圧印加部3bに正の電位が印加されて伸縮素子1bが伸張されて、図2(b)に示す如く、各板状積層体8は屈曲状態となり、移動部6は上方へ動作される。なお、それ以外は、上記図1に示した実施形態と同様に構成されており、同上記実施形態におけると同様の作用効果が奏される。

【0031】図3は、本発明の請求項1、3、5に対応する更に別の実施形態を示し、該実施形態のアクチュエータにおいては、板状積層体8の中程部分に、該板状積層体8の板面と略直交する方向で直線的に動作される移動部6を設けている。この場合、板状積層体8はその両端部分が固定端部11として固定されて略水平状態に配置され、該板状積層体8の中央下面に移動部6が設けられて

【0032】したがって、実施形態のアクチュエータにおいては、電圧印加部3aに正の電位が印加されて上側の伸縮素子1aが伸張され、電圧印加部3bに負の電位が印加されて下側の伸縮素子1bが収縮されると、図3(b)に示す如く、板状積層体8はその中程部分が上方へと反るように屈曲変形して移動部6は上方へ動作される。これとは逆に電位が印加されると、同板状積層体8はその中程部分が下方へと反るように屈曲変形して移動部6は下方へ動作される。又、電位の印加が停止されると、図3(a)に示す如く、同板状積層体8は中立の直線状態に保持される。すなわち、この場合は特に、移動部6を単一の板状積層体8でもってこれと略直交する方向に往復運動させることができる。なお、それ以外は、上記図1に示した実施形態と同様に構成されており、請求項1、3に係る作用効果が同上記実施形態におけると同様に奏される。

【0033】図4は、本発明の請求項1～3、6に対応する更に別の実施形態を示し、該実施形態のアクチュエータにおいては、板状積層体8をその一方の伸縮素子1a

が外周、他方の伸縮素子1bが内周となる円環状に形成し、該円環状となる板状積層体8の周方向における一部分を、同板状積層体8の径方向で直線的に動作される移動部6となしている。この場合、円環状の板状積層体8の上端部分の外周側に電圧印加部3a、同上端部分の内周側に電圧印加部3bが配設されて、各々は伸縮素子1a、1bに接続されている。又、同板状積層体8の下端部分の内周側に移動部6が設けられ、該移動部6と前記電圧印加部3bとの間にバイアス機構7が張設されている。

10 【0034】したがって、該実施形態のアクチュエータにおいては、電圧印加部3aに正の電位が印加されて外周側の伸縮素子1aが伸張され、電圧印加部3bに負の電位が印加されて内周側の伸縮素子1bが収縮されると、円環状の板状積層体8が縮小変形して移動部6は上方へ動作される。これとは逆に電位が印加されると、同板状積層体8が膨大変形して移動部6は下方へ動作され、その際、バイアス機構7によって移動部6が動作される下方への力が発生されるので、充分な動作力を得ることができる。

20 【0035】すなわち、この場合は特に、板状積層体8が円環状に形成され、その周方向における下端部分に上下径方向で直線的に動作される移動部6が設けられて、該移動部6と反対側で径方向に対向する同板状積層体8の上端部分を固定するだけの簡単な構造となり、同移動部6を円環状の板状積層体8の膨大縮小変形によって確実に安定した状態で上下方向に往復運動させることができる。このような変形動作をなす該実施形態のアクチュエータは、例えば、指、腕等の圧迫マッサージ機の動力発生機構としても好適に利用することができる。なお、それ以外は、上記図1に示した実施形態と同様に構成されており、請求項1～3に係る作用効果が同上記実施形態におけると同様に奏される。

【0036】又、該実施形態のアクチュエータは、図5に示す如く、STAGE13を二次元移動させる動作発生機構として好適に使用することもできる。この場合、円形状のSTAGE13の周囲に複数のアクチュエータ本体5が対向配置され、各アクチュエータ本体5に設けられる移動部6がSTAGE13の外周に接合され、各板状積層体8の同移動部6と反対側で径方向に対向する部分の外周側の伸縮素子1aに円環状枠体12の内周部分が接合されている。又、同円環状枠体12は導電性材料で形成され、一方の電圧印加部3aと電気的に接続されて、その内側に各アクチュエータ本体5を介してSTAGE13を保持するもので、各アクチュエータ本体5に設けられる移動部6には他方の電圧印加部3bが各々配設されて、いずれの電圧印加部3bに電圧を印加するかはセレクトスイッチ14によって選択変更することができる。したがって、この場合、セレクトスイッチ14を操作して、所定のアクチュエータ本体5の円環状の板状積層体8を前述したように膨大縮小変形させることにより、往復運動する移動

部6間に保持されるSTAGE13をXY平面上で所望の方向へ動作させることができる。

【0037】図6は、本発明の請求項1、7に対応する更に別の実施形態を示し、該実施形態のアクチュエータにおいては、単一の伸縮素子1をスパイラル状に形成し、該伸縮素子1のスパイラル曲線に沿う伸縮により同スパイラルの軸線方向に沿って直線的に動作される移動部6を、同伸縮素子1の端部に設けている。

【0038】この場合、一方の電圧印加部3aが銅、銀、白金等で円柱棒状に形成され、該電圧印加部3aの外周面全体に電解質部4が層設され、該電解質部4の外周面に帯状の伸縮素子1が摺動自在となるようスパイラル状に巻装され、該伸縮素子1の上端に他方の電圧印加部3bが電気的に接続されて固定され、同伸縮素子1の下端に同電解質部4の下端部分に上下スライド自在に嵌装される短円筒状の移動部6が結合されている。

【0039】したがって、該実施形態のアクチュエータにおいては、伸縮素子1がスパイラル状に形成されてコンパクトに納まる。又、伸縮素子1に接続される電圧印加部3bに正の電位が印加されると該伸縮素子1は伸張し、同電圧印加部3bに負の電位が印加されると同伸縮素子1は収縮する。その際、伸縮素子1はスパイラル曲線に沿って電解質部4の外周面に斜め周方向で摺接しながら大きな変位量で伸縮して、該大きな変位量の伸縮が同スパイラルの軸線方向（円柱棒状の長手方向）に沿った小さな変位量となる移動部6の直線的な上下方向の動作に変換され、より強い動作力を得ることができる。なお、それ以外は、上記図1に示した実施形態と同様に構成されており、請求項1に係る作用効果が同上記実施形態におけると同様に奏される。

【0040】図7は、本発明の請求項1、7、8に対応する更に別の実施形態を示し、該実施形態のアクチュエータにおいては、上記スパイラル状の伸縮素子1の伸張時に移動部6が動作される下方への力を発生する同じスパイラル状のスプリングであるバイアス機構7を備え、該バイアス機構7に沿って同伸縮素子1を一体化している。この場合、図7(b)に示す如く、バネ鋼材でなるバイアス機構7が一方の電圧印加部3aとして形成され、該バイアス機構7の外周全体に電解質部4を介して伸縮素子1が層設され、該伸縮素子1の外周全体に他方の電圧印加部3bが層設被装されている。

【0041】したがって、該実施形態のアクチュエータにおいては、上記スパイラル状の伸縮素子1がスプリングであるバイアス機構7に沿ってこれと一体化形成されるので、該バイアス機構7によって伸縮素子1の伸張時に移動部6が動作される下方への力が発生され、伸縮素子1が伸張される際にも充分な動作力を得ることができる。又、バイアス機構7によって外力が吸収され移動部6の無理な動作もなくなつて、アクチュエータ本体5は破損し難くなる。なお、それ以外は、上記図6に示した

実施形態と同様に構成されており、同上記実施形態におけると同様の作用効果が奏される。

【0042】

【発明の効果】上述の如く、本発明の請求項1記載のアクチュエータにおいては、電圧印加部に正、負の電位が印加されることにより π 共役型高分子材料でなる伸縮素子は強力に伸縮して、確実にアクチュエータ本体に設けられる移動部が直線的に動作され、しかも、該動作されたアクチュエータ本体の形態を繰り返して電圧印加し続けることなく確実に持続させることができる。

【0043】又、本発明の請求項2記載のアクチュエータにおいては、特に、バイアス機構によって伸縮素子の伸張時に移動部が動作される方向への力が発生され、伸縮素子が伸張される際にも充分な動作力を得ることができ、又、伸縮素子が収縮される際には、支障なく伸縮素子が収縮して移動部は逆の方向へ動作される。

【0044】又、本発明の請求項3記載のアクチュエータにおいては、特に、印加される電位を正、負変換することで、板状積層体が相反する側へ屈曲変形され、簡単な機構でもって移動部を確実に往復運動させることができる。

【0045】又、本発明の請求項4記載のアクチュエータにおいては、特に、上記板状積層体が対向配置され、移動部を両側の板状積層体の屈曲変形によって確実に安定した状態で往復運動させることができる。

【0046】又、本発明の請求項5記載のアクチュエータにおいては、特に、上記板状積層体の中程部分に設けられる移動部を、単一の同板状積層体でもってこれと略直交する方向に往復運動させることができる。

【0047】又、本発明の請求項6記載のアクチュエータにおいては、特に、上記板状積層体が円環状に形成され、その周方向における一部分となる移動部を、円環状の板状積層体が膨大縮小する屈曲変形によって確実に安定した状態で往復運動させることができる。

【0048】又、本発明の請求項7記載のアクチュエータにおいては、特に、伸縮素子がスパイラル状に形成されてコンパクトに納まり、しかも、該伸縮素子のスパイラル状に沿った大きな変位量での伸縮が移動部の直線的な動作に変換され、より強い動作力を得ることができる。

【0049】又、本発明の請求項8記載のアクチュエータにおいては、特に、上記スパイラル状の伸縮素子がスプリングであるバイアス機構と一体化形成されて、該伸縮素子が伸張される際にも充分な動作力を得ることができ、又、外力が吸収され移動部の無理な動作もなくなつて、アクチュエータ本体は破損し難くなる。

【図面の簡単な説明】

【図1】本発明の一実施形態であるアクチュエータを示し、(a)(b)はその各々異なる状態における側面図。

【図2】別の実施形態であるアクチュエータを示し、(a) (b) はその各々異なる状態における側面図、(c) はその板状積層体を示す斜視図。

【図3】更に別の実施形態であるアクチュエータを示し、(a) はその側面図、(b) はその板状積層体が屈曲変形した状態を示す側面図。

【図4】更に別の実施形態であるアクチュエータを示し、(a) はその側面図、(b) はその板状積層体を示す斜視図。

【図5】同アクチュエータの一使用形態を例示する平面図。

【図6】更に別の実施形態であるアクチュエータを示す斜視図。

【図7】更に別の実施形態であるアクチュエータを示

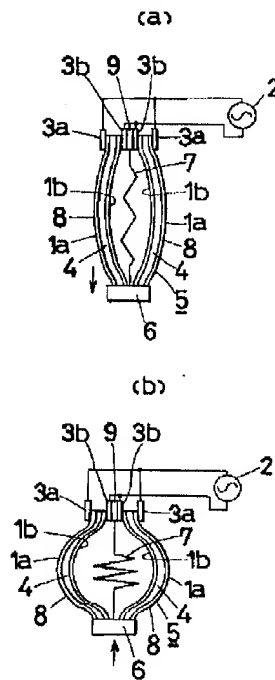
し、(a) はその斜視図、(b) はその要部を示す拡大斜視図。

【図8】従来例であるアクチュエータを示す断面図。

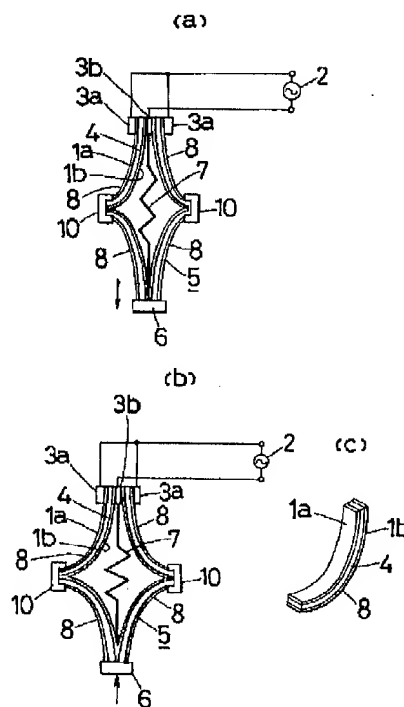
【符号の説明】

- 1 伸縮素子
- 2 電源部
- 3 電圧印加部
- 4 電解質部
- 5 アクチュエータ本体
- 6 移動部
- 7 バイアス機構
- 8 板状積層体

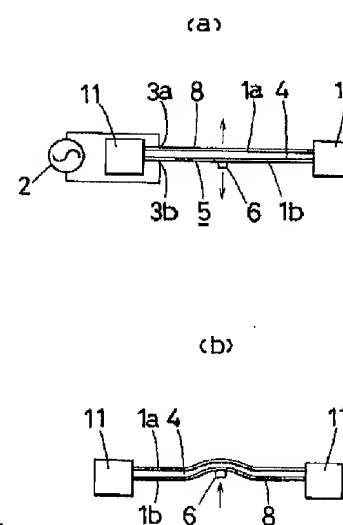
【図1】



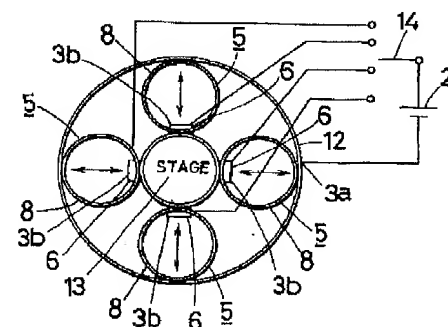
【図2】



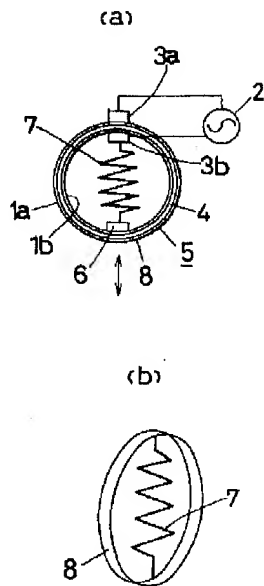
【図3】



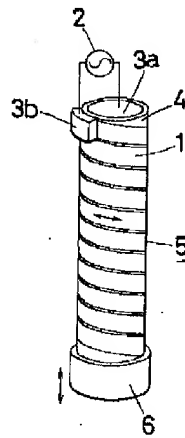
【図5】



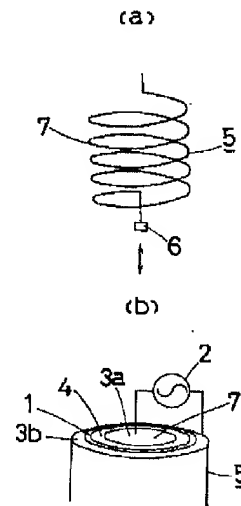
【図4】



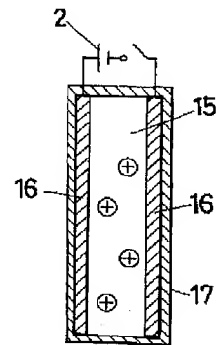
【図6】



【図7】



【図8】



フロントページの続き

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